The Basics of the M&S VV&A Process

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Agenda

- Definitions
- The VV&A Processes
- VV&A as Applied to the Simulation Categories
- Documentation
- Conclusion

Definitions

What is Verification?

- The process of determining that a model implementation accurately represents the developer's conceptual description and specifications.
- Provides information about M&S attributes that is used to assess & demonstrate suitability
- Goal: Did I build it **RIGHT**?

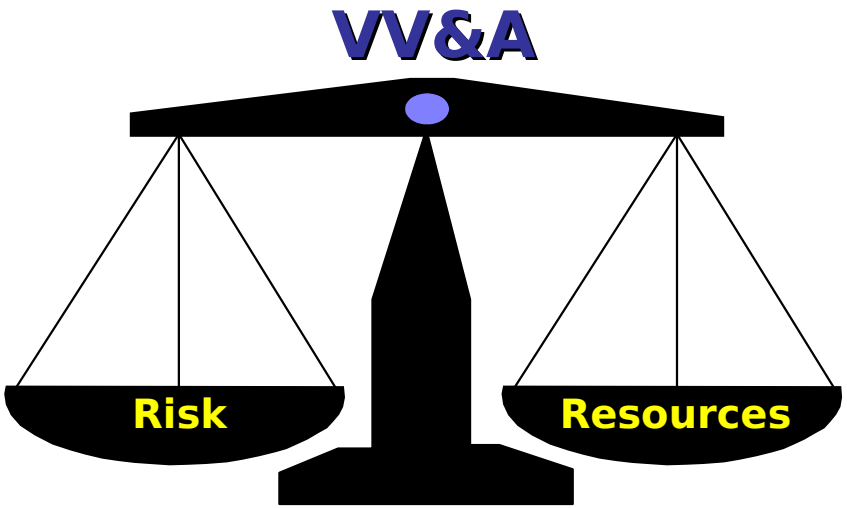
What is Validation?

- The process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model.
- Provides information about M&S attributes that is used to assess & demonstrate suitability
- Goal: Did I build the **RIGHT** thing?

What is Accreditation?

- The official certification that a model, simulation, or federation of models and simulations and its associated data are acceptable for use for a specific purpose.
- The certification is based on the accreditation assessment.
- Goal: Are the results of the M&S **FIT FOR PURPOSE** and **USEFUL** for making decisions?

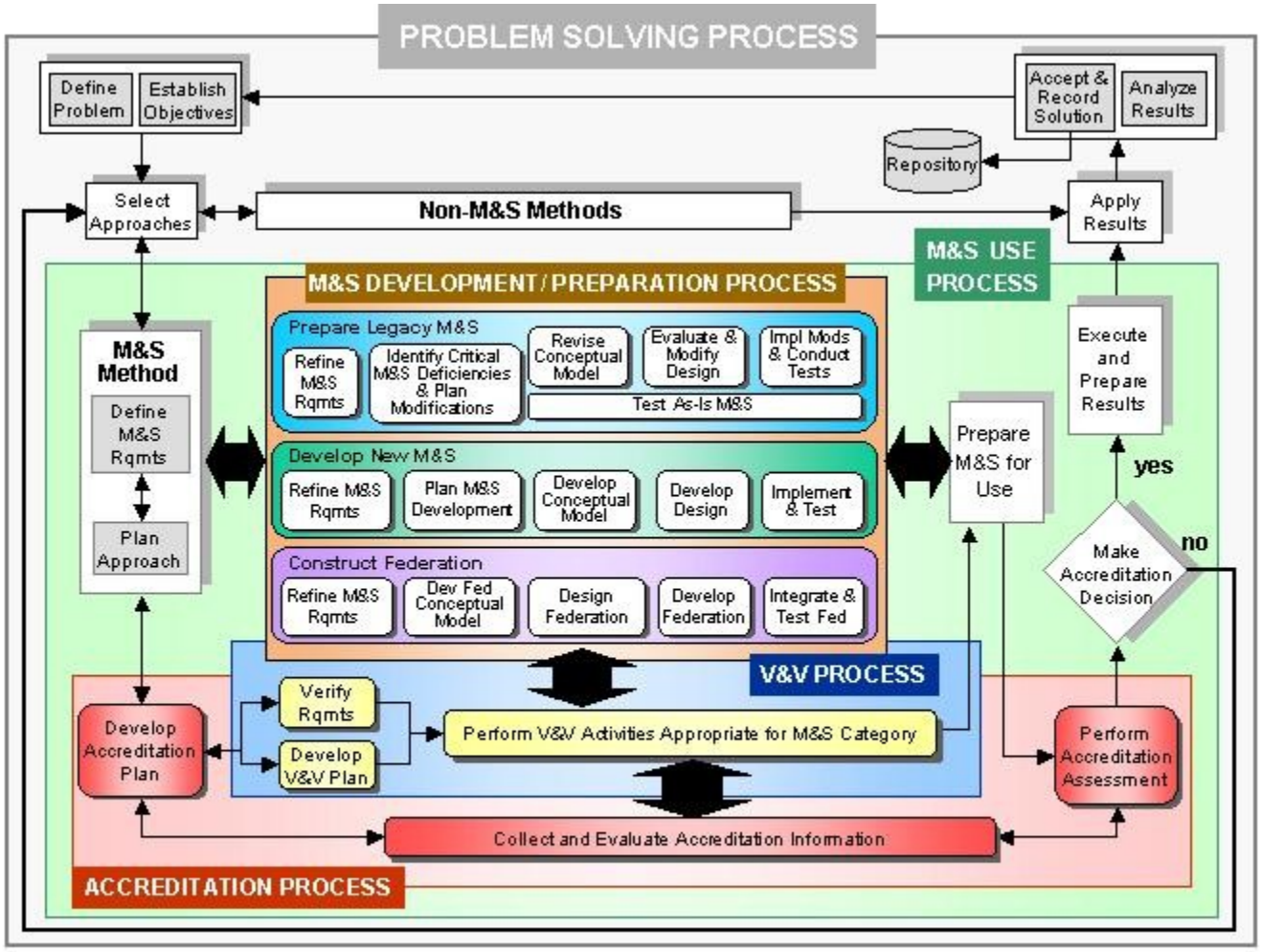
The Balancing Act



Balancing the cost of knowing against the risk of assuming.

The VV&A Processes

VV&A and the Problem Solving Process



The Overall Problem Solving Process

From the RPG

Tailoring Guidance: Stay Focused on the Problem

- Maintain a problem orientation
  - Understand the relationships between
    - The problem being solved
    - The role of M&S in the problem
    - The role of VV&A in establishing M&S credibility
  - If the problem is too complex, decompose it into workable units
    - Ensure that you are still trying to solve the same problem
- Focus on accreditation
  - Ensure that the V&V evidence is clearly applicable to the intended purpose - solving ‘this’ problem

Tailoring Guidance: Understand the Problem

- Define the explicit problem requirements
  - What specific questions are to be answered?
  - What are the MOE's?
  - How will M&S be used?
  - What do the M&S need to do?
  - How good do the M&S need to be?
- Define what question(s) need to be answered…
  - Define what the M&S needs really are
  - Define the acceptability criteria needed to assess M&S attributes and the specific needs
  - Identify the M&S choices, the VV&A credibility needs, and the level of development resources ($$$) necessary to meet defined needs

An explicit statement of the problem is the most important aspect of cost-effective VV&A and the hardest to come by

Tailoring Guidance: Know the Level of Credibility Required

- Credibility is Defined by the Customer - but it has a cost
  - Ensure that the right people make the decision on the level of credibility they need
  - Ensure the Level of Credibility is explicitly defined by the Acceptability Criteria
- Credibility and Risk Assessment - know the limits & tolerances
  - How will accepting a bad answer affect the 'end user' decision or results
  - What are the costs in time, equipment and decisions for lower levels of results
- Tailor Risk Analysis to Level of Credibility Requirements
  - Determine how much evidence will be needed to accredit M&S
  - Determine the impact of NOT doing (or failing) V&V
  - Provide forums to facilitate development of workaround strategies and assessment of these solutions- both positive and negative impacts

Tailoring Guidance: Determine How to Optimize Resources

- Not all V&V supports Accreditation to the same extent
  - Know what each type of M&S information 'buys' you relative to the cost of producing it
- Try to avoid (re)doing it all yourself
  - Capitalize on existing VV&A information whenever possible
  - Know how to extract useful data from software V&V results
- Cooperative evolution for resources : use common VV&A data elements and report structure
  - The VV&A Templates provides a common structure for documenting VV&A information
  - Each of the Services has adopted a common database structure for their M&S Resource Repositories

Challenge Issues that Impact VV&A Implementation

- The lack of a well defined referent
- Determining how to use and when to use Subject Matter Experts
- The lack of insight into the M&S
- The lack of M&S stability
- Starting the V&V/A process “late”
- Keeping the second “V” in V&V

VV&A as Applied to the Simulation Categories

Simulation Categories

New M&S Development

Any stand-alone model or simulation under development being built to address the intended purpose or purposes of the User.

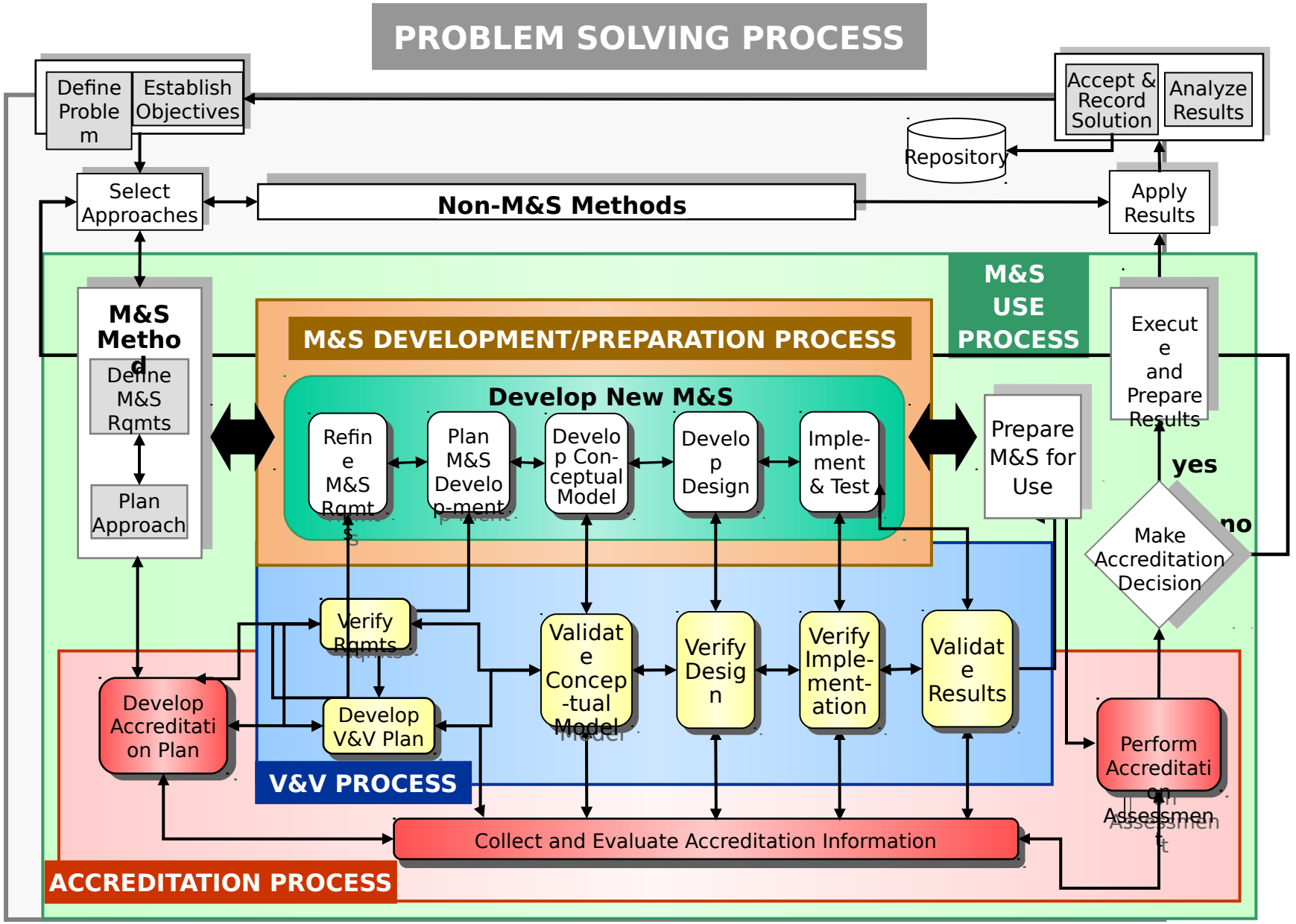
Legacy

Any model or simulation that was developed either in the past or for a different purpose.

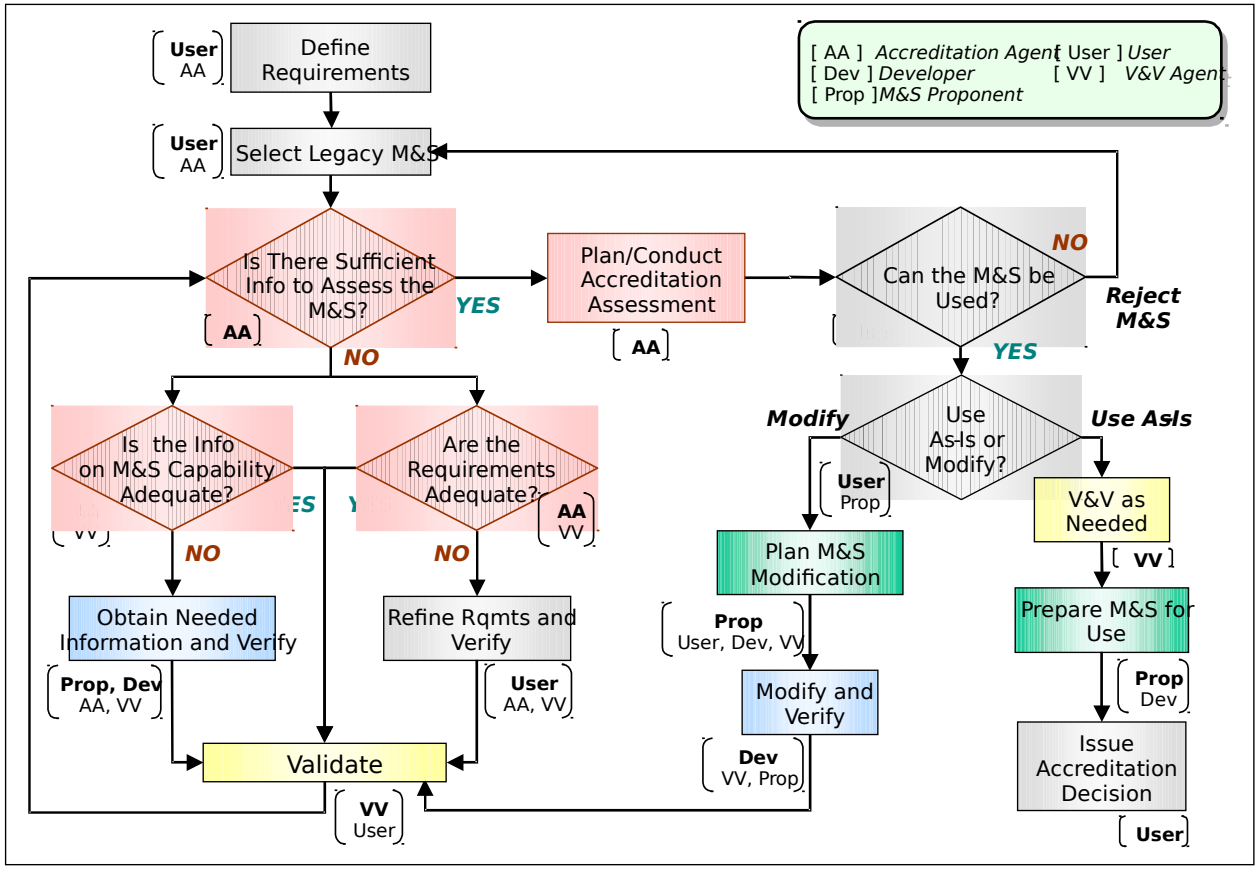
Federation

A system of interacting models and/or simulations, with supporting infrastructure, based on a common understanding of the objects portrayed in the system.

VV&A and New M&S Development



VV&A and Legacy M&S



Advantages of Using Legacy M&S

- Starting with a legacy simulation may be more expedient, requiring less time and fewer resources than a new development
- The experience of previous developers and users may be leveraged to establish a knowledge base that can provide guidance and support training
- Testing and VV&A histories can provide evidence of simulation capabilities and limitations allowing the current effort to focus on high risk areas
- A legacy simulation with a good reputation for providing credible results in similar applications can increase the simulation's credibility (i.e., the User's confidence in the simulation's ability to address the current situation) due to
  - the demonstrated ability to address similar requirements
  - the demonstrated capabilities of the existing simulation
  - the direct experiences of previous users who successfully applied the simulation to related problems

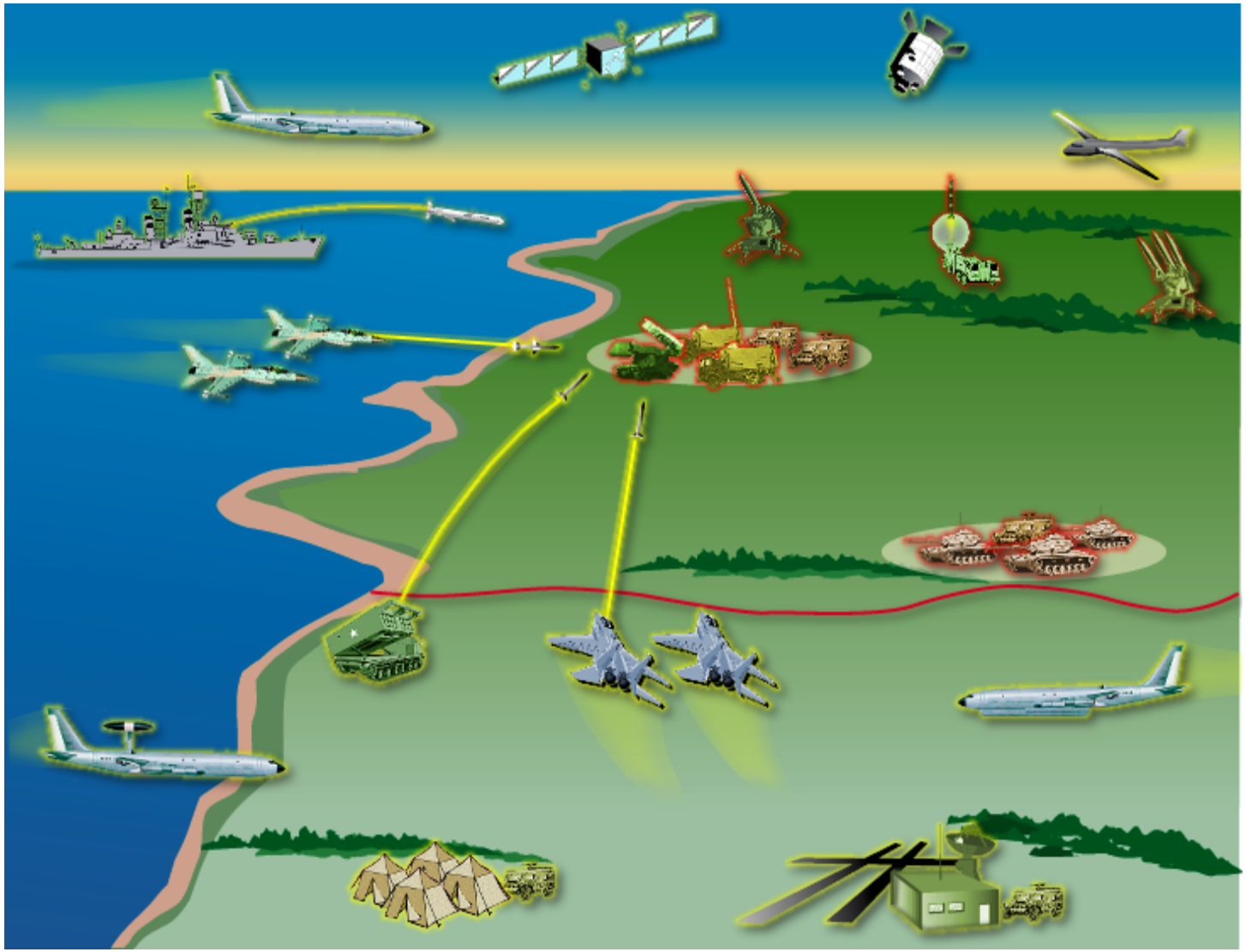
Disadvantages of Using Legacy M&S

- The simulation was developed to address different requirements
- Unexpected and undesirable side effects may occur during execution of the code
- The simulation comes with specific hardware and software, which may be obsolete
- The simulation comes with specific data needs, however the data to fulfill those needs may no longer be authoritative or available
- Information about the simulation and its previous usage may be incomplete or inconsistent
- Participants (e.g., Accreditation Agent, V&V Agent) may need time up front to acquire knowledge about the simulation

What Can Help Reduce Legacy V&V Cost

- Documentation that can directly support the accreditation assessment can reduce the burden of an extensive discovery effort
- Documentation that completely and accurately describes simulation capabilities and use history can reduce the discovery and training costs
- A simulation under configuration control with an established user community that can provide necessary information can reduce the support and discovery costs
- Participants familiar with the simulation can reduce the need for extensive training

Scope of the Distributed M&S Problem



Distributed M&S: Technical Interoperability

- Characterized by the ability of federates to ***physically connect and exchange data*** in accordance with the Federation Object Model (FOM)
- Involves the use of common standards, compatible interfaces and coordinated data structures
- Elements of technical interoperability
  - Hardware compatibility
  - Standards compatibility
  - Time management coordination
  - Coordinated use of Run Time Infrastructure (RTI) services
  - Security issues

From "HLA and Beyond: Interoperability Challenges" by Dahmann, Salisbury, Barry, Turrell, and Blemberg (99F-SIW-073)

Distributed M&S: Substantive Interoperability

The capability of federates, when connected, to provide adequate, accurate & consistent simulated representations that adhere to the principles of “fair fight” & address the mission objectives.

> *“HLA supports the technical interoperability between distributed simulations. Substantive interoperability, on the other hand, remains a key challenge to achieving complete distributed simulation interoperability.”* [Dahmann et al.]

Substantive Interoperability Issues

- Logical interaction between entities modeled in different federates
- Temporal resolution
- Spatial resolution
- Coherent relationships between the components of the physical environment: ground, ocean, atmosphere, weather, infrared, and electromagnetic

Documentation

Documentation Philosophy

- Organize information according to a standard outline
  - Rationale
    - Eases the comparison of data with accreditation requirements
    - Facilitates V&V data accumulation for future use
    - Reduces costs of multiple accreditations over time
  - Specific outlines vary with type of data element
- Structure V&V results to facilitate comparison with M&S requirements
  - Include description of how the results impact m&s use
  - State newly discovered discrepancies as assumptions, limitations on model use, or as errors
  - Identify the range of applicability for all results
    - Particularly regarding any limitations or errors
  - Ensure results are linked to the applicable M&S version
- Configuration Management

VV&A Documentation Templates

Accreditation Plan	V&V Plan	V&V Report	Accreditation Report
Executive Summary	Executive Summary	Executive Summary	Executive Summary
1 Problem Statement	1 Problem Statement	1 Problem Statement	1 Problem Statement
2 M&S Requirements and Acceptability Criteria	2 M&S Requirements and Acceptability Criteria	2 M&S Requirements and Acceptability Criteria	2 M&S Requirements and Acceptability Criteria
3 M&S Assumptions, Capabilities, Limitations & Risks/Impacts	3 M&S Assumptions, Capabilities, Limitations & Risks/Impacts	3 M&S Assumptions, Capabilities, Limitations & Risks/Impacts	3 M&S Assumptions, Capabilities, Limitations & Risks/Impacts
4 Accreditation Methodology	4 V&V Methodology	4 V&V Task Analysis	4 Accreditation Assessment
5 Accreditation Issues	5 V&V Issues	5 V&V Recommendations	5 Accreditation Recommendations
6 Key Participants	6 Key Participants	6 Key Participants	6 Key Participants
7 Planned Accreditation Resources	7 Planned V&V Resources	7 Actual V&V Resources	7 Actual Accreditation Resources
		8 V&V Lessons Learned	8 Accreditation Lessons Learned
Suggested Appendices: A M&S Description B M&S Requirements Traceability Matrix C Basis of Comparison D References E Acronyms F Glossary G Accreditation Programmatics H Distribution List	Suggested Appendices: A M&S Description B M&S Requirements Traceability Matrix C Basis of Comparison D References E Acronyms F Glossary G V&V Programmatics H Distribution List	Suggested Appendices: A M&S Description B M&S Requirements Traceability Matrix C Basis of Comparison D References E Acronyms F Glossary G V&V Programmatics H Distribution List	Suggested Appendices: A M&S Description B M&S Requirements Traceability Matrix C Basis of Comparison D References E Acronyms F Glossary G Accreditation Programmatics H Distribution List

VV&A Data Archiving

- VV&A Documents
  - Should be archived in central location:
    - Defense Department level or
    - Program level
  - Indexed in a electronic database
  - Possibly available on-line
- Electronic Database
  - Should contain summarized, unclassified data from VV&A reports

VV&A data are only useful if they are documented, and the documentation is readily available to model users.

Conclusion

Summary of VV&A

- Cost-effective accreditation requires
  - Complete problem definition
  - Clear application description
  - Explicit statements of M&S requirements and acceptability criteria
  - A well-planned, tailored and focused accreditation assessment effort

- Efficient V&V to support accreditation requires
  - A clearly defined application context to permit focused V&V efforts
  - The use of risk to focus and tailor the V&V effort
  - A clear understanding of how each V&V activity contributes to M&S credibility
  - A means of extracting key accreditation support information from previous V&V (and other M&S) efforts
  - An efficient means to produce, document, and archive all V&V information (from software and M&S V&V)

M&S VV&A

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